

OSD/AT&L Clean Fuel Initiative

Vision: DoD/AT&L intends to catalyze commercial industry to produce clean fuels for the military from secure domestic resources using environmentally sensitive processes.

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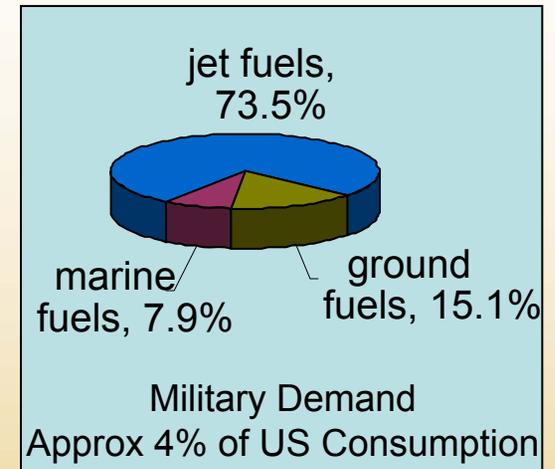
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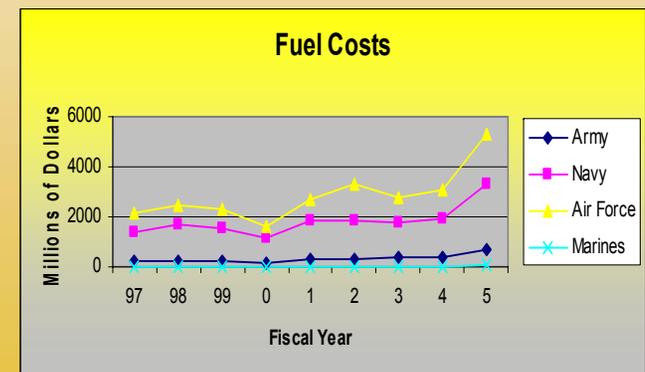
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DOD Concerns

- **Secure and reliable sources of energy**
 - **Dependent on foreign oil**
 - **Becoming dependent on foreign refined fuels**
- **Supply chain vulnerability**
 - **Dependent on mega refineries**
 - **Terrorist threats or natural disasters**
- **Need for cleaner fuels**
 - **DoD exempt from some EPA regulations**
- **Potential limits on deployments**
 - **Possible Conflict with EU rules**

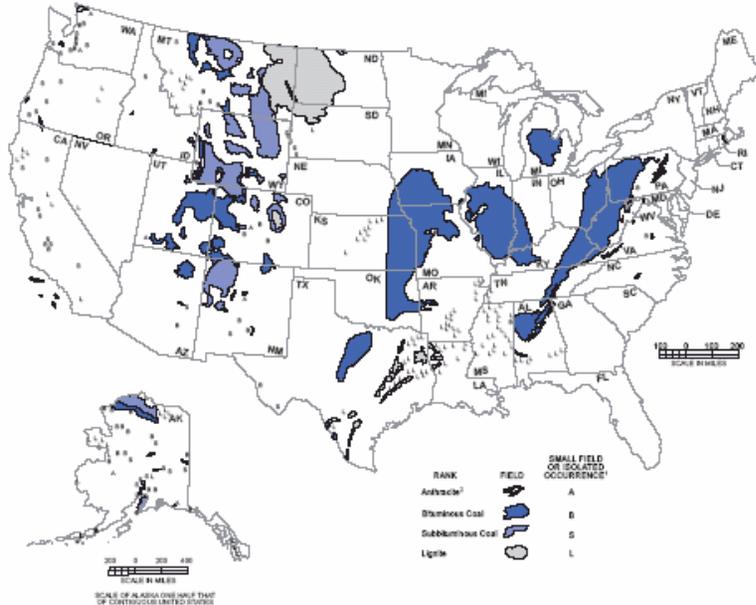


Ref: DESC Help Book



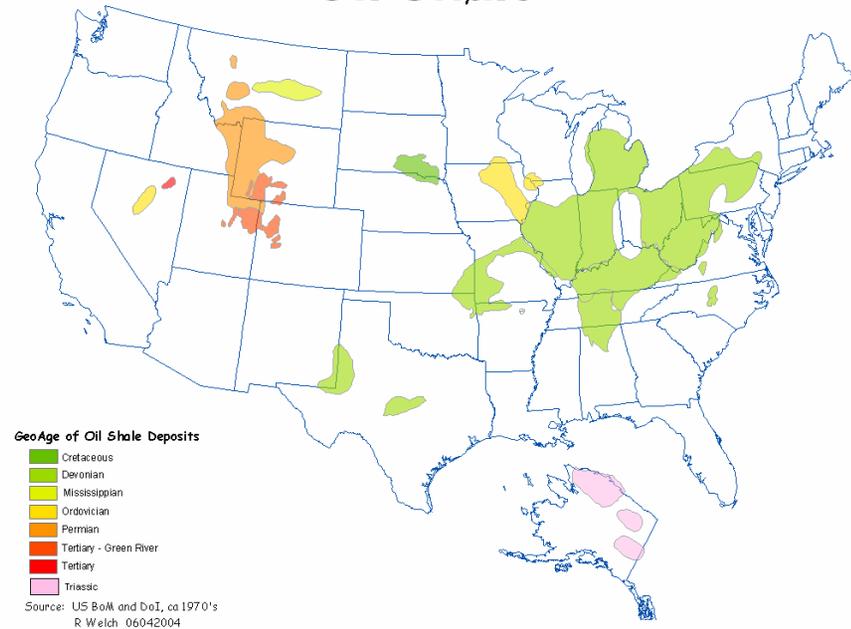
Evaluating All US Energy Resources

Coal



Sources: United States Geological Survey, Coalfields of the United States, 1960-1961; Texas Bureau of Economic Geology, Lignite Resources in Texas, 1960; Louisiana Geological Survey, Near Surface Lignite in Louisiana, 1981; Colorado Geological Survey, Coal Resources and Development Map, 1981; and Mississippi Bureau of Geology, 1963.

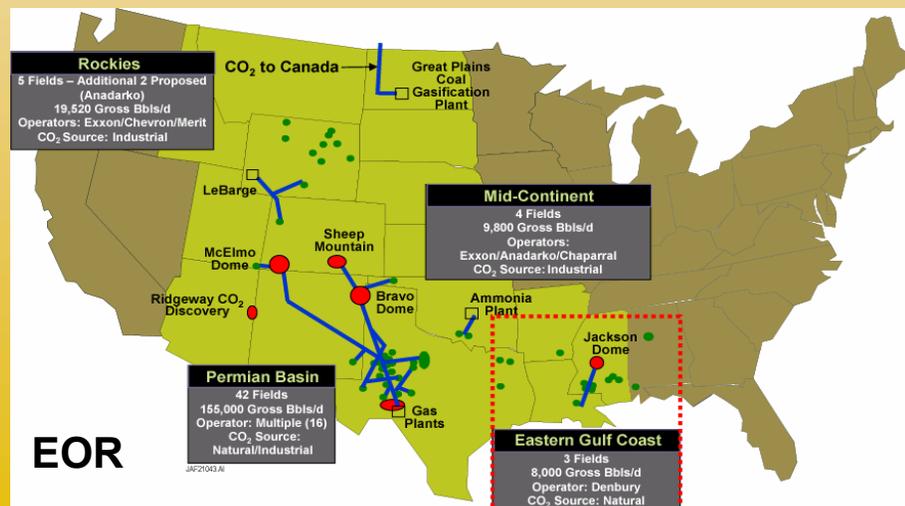
Oil Shale



Domestic Resources

- 1.4 trillion barrels (shale)
- 800 billion barrels of FT (coal)
- 0.15 billion barrels (pet coke)
- 22.7 billion barrels oil reserves
- 32+ billion barrels of oil (EOR)
- Renewables (TBD)

Total 2.3+ trillion barrels equivalent



Bottom Line: We could be the New Middle East—2.3+ Trillion Barrels

Old Middle East

Saudi Arabia:	261.8 Billion Barrels
Iraq:	112.5 Billion Barrels
UAE:	97.8 Billion Barrels
Kuwait:	96.5 Billion Barrels
Iran:	89.7 Billion Barrels
Qatar:	15.2 Billion Barrels
Oman:	5.5 Billion Barrels
Yemen:	4.0 Billion Barrels
Syria:	<u>2.5 Billion Barrels</u>

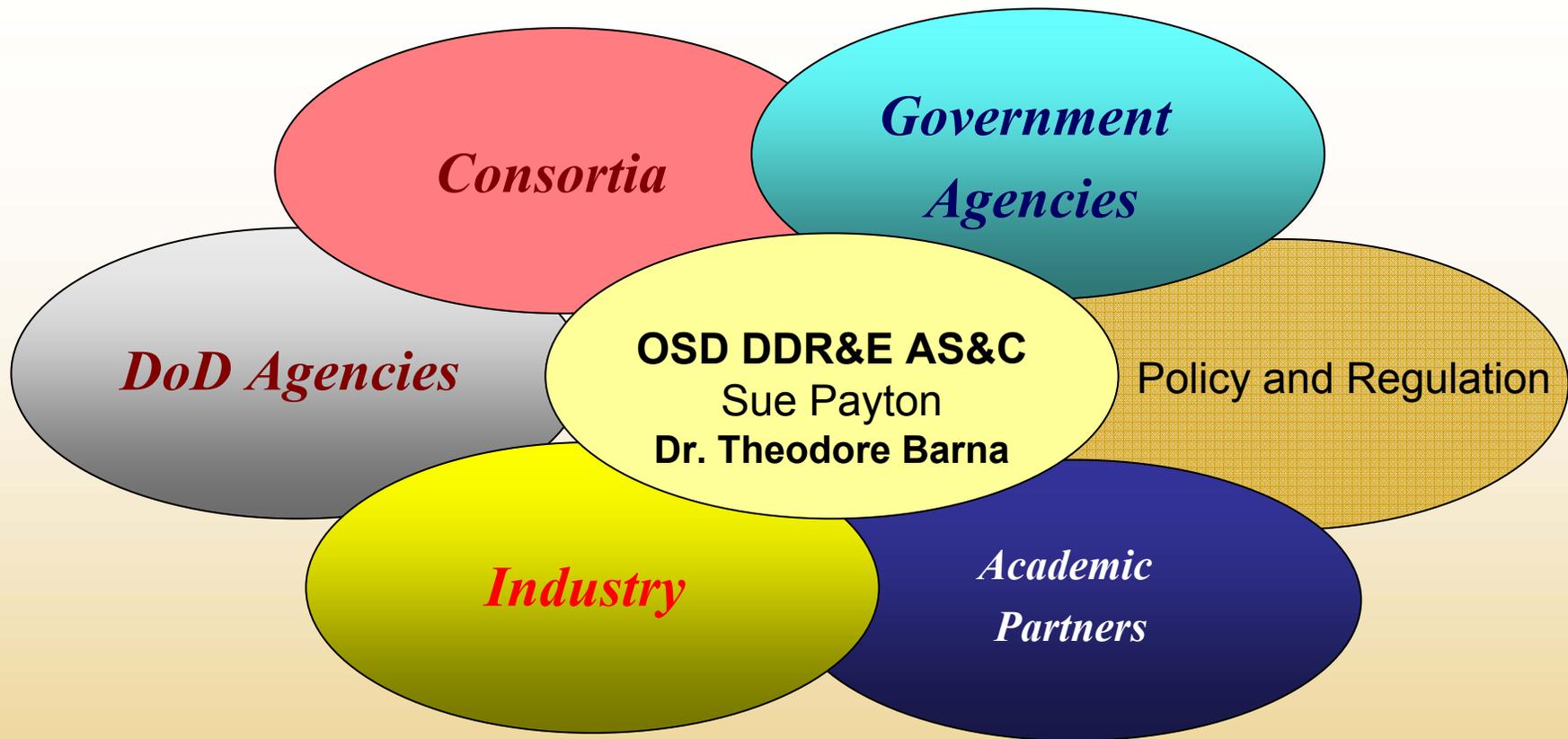
TOTAL 685.5 Billion Barrels

Appalachian States Have More Equivalent Barrels of Oil (904.6 Billion bbls) as Middle East (685.5 Billion bbls)

	<u>Coal</u>	<u>Shale</u>
• Illinois	218 B Bbls	
• Kentucky	64 B Bbls	190 B Bbls
• West Virginia	70 B Bbls	
• Pennsylvania	57 B Bbls	
• Ohio	47 B Bbls	140 B Bbls
• Indiana	20 B Bbls	40 B Bbls
• Alabama	9 B Bbls	4 B Bbls
• Tennessee	<u>1.6 B Bbls</u>	<u>44 B Bbls</u>
	486.6 B Bbls	418 B Bbls

Western States Have More Barrels of Oil (1.5 Trillion bbls) than the Middle East (685 Billion bbls)

	<u>Coal</u>	<u>Oil Shale</u>
• Alaska	12 B Bbls	
• Colorado	33 B Bbls	600 B Bbls
• Montana	240 B Bbls	
• New Mexico	25 B Bbls	
• North Dakota	20 B Bbls	
• Utah	12 B Bbls	300 B Bbls
• Wyoming	<u>135 B Bbls</u>	<u>150 B Bbls</u>
	477 B Bbls	1050 B Bbls



Office of the Secretary Of Defense Initiative

- Form partnerships with other government agencies (DOE, DOT, EPA, Interior, Commerce etc.), industry and academia
- Catalyze industry development and investment in energy resources: Total Energy Development Program (TED)
- Evaluate, demonstrate, certify and implement turbine fuels produced from diverse energy resources: Battlefield Use Fuel of the Future (BUFF)

Clean Fuels Initiative Two Pronged Approach

- Total Energy Development Program (TED)**
 - Catalyze commercial production of fuels from alternative energy resources**
- Joint Battlefield Use Future Fuel of the Future (JBUFF) Program**
 - Evaluate, demonstrate, certify turbine fuels from alternative energy resources for use in tactical vehicles, aircraft and ships**

Total Energy Development (TED)

- **Use all secure indigenous sources of energy**
 - **Coal, shale oil, petroleum coke, renewables**
 - **Dispersed production facilities**

- **Minimize government funding—focus on qualification and certification**

- **Meet existing government mandates and executive orders to ensure environmental compliance**

- **Couple program with advanced technologies to reduce the consumption of fuel**
 - **For example: Future Tactical Truck System, Fuel Cells, Advanced Turbine Engine Technologies (IHPTET/VAATE)**

- **Make a better fuel from coal and petroleum coke (Fischer Tropsch fuels) and oil shale**
 - **Low (or no) Sulfur, cleaner burning, bio-degradable, low (or no) aromatics, reduced particulate emissions**
 - **Blends near term, neat fuel future goal**

- **Use Environmentally sensitive processes to produce fuel**
 - **Clean Coal Technologies such as the Fischer-Tropsch process, Mahogany Shale Research Project, Direct Coal Liquefaction**

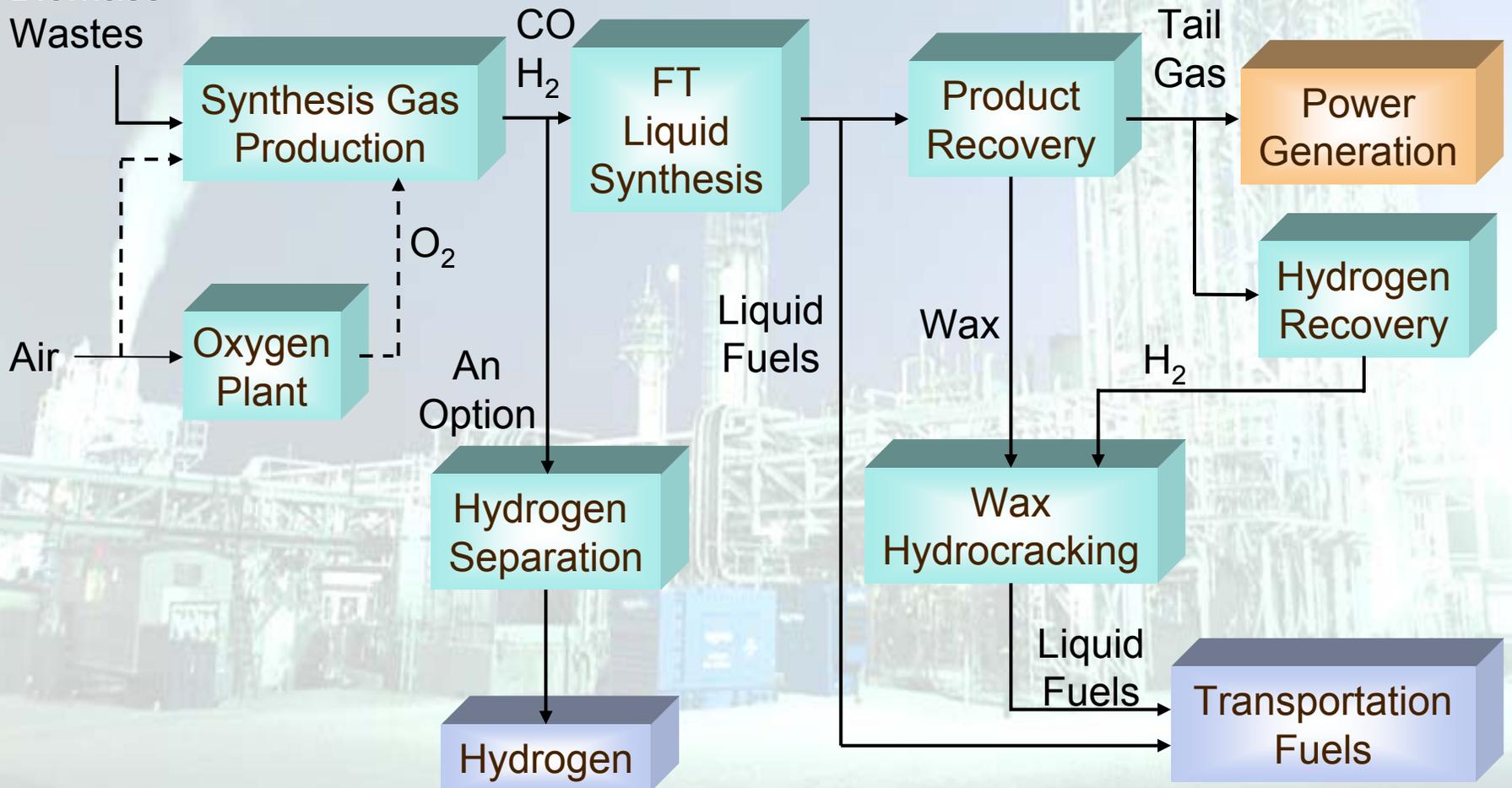
 - **CO₂ sequestration for enhanced oil recovery (EOR)**

Technologies to Produce Clean Fuels

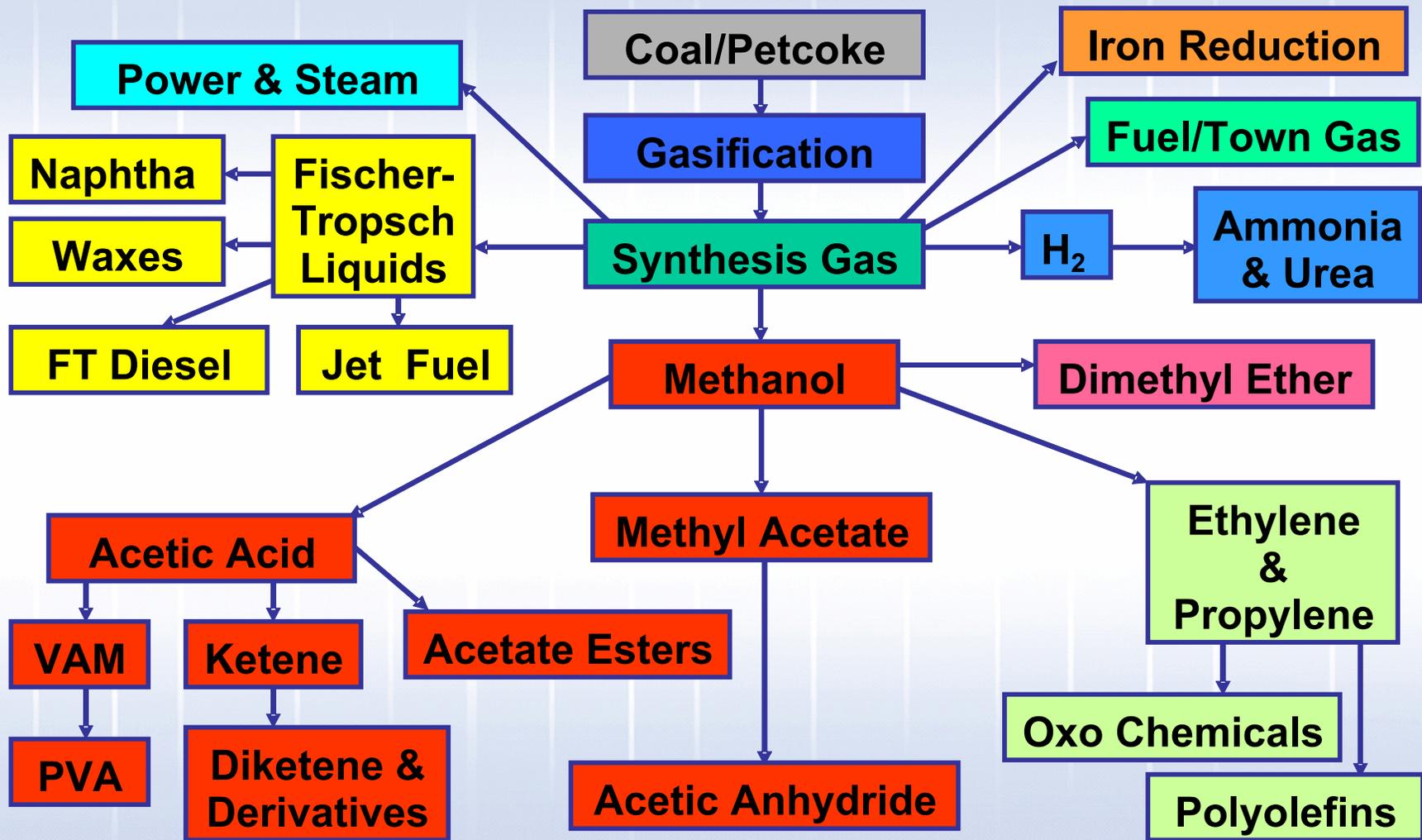
- Indirect coal liquefaction – Coal gasification followed by fuel production using the Fischer Tropsch process
- Direct coal liquefaction – Coal liquefied using the HTI process followed by conventional hydrocarbon upgrading
- In-Situ recovery of shale – Oil shale retorting underground (i.e. Shell Mahogany Research Project) followed by conventional hydrocarbon upgrading
- Above ground retorting of shale oil – oil shale retorting above ground followed by conventional hydrocarbon upgrading
- Domestic US oil recovered by enhanced oil recovery techniques using waste CO₂ followed by conventional hydrocarbon upgrading

Fischer-Tropsch Technology

Natural Gas
Coal
Pet Coke
Biomass
Wastes



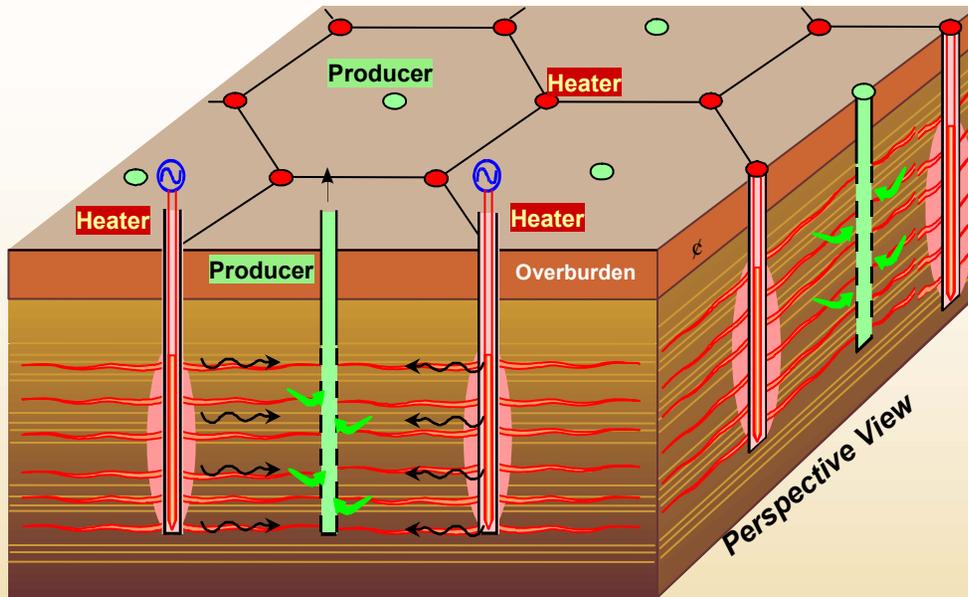
Polygeneration Potential of Gasification



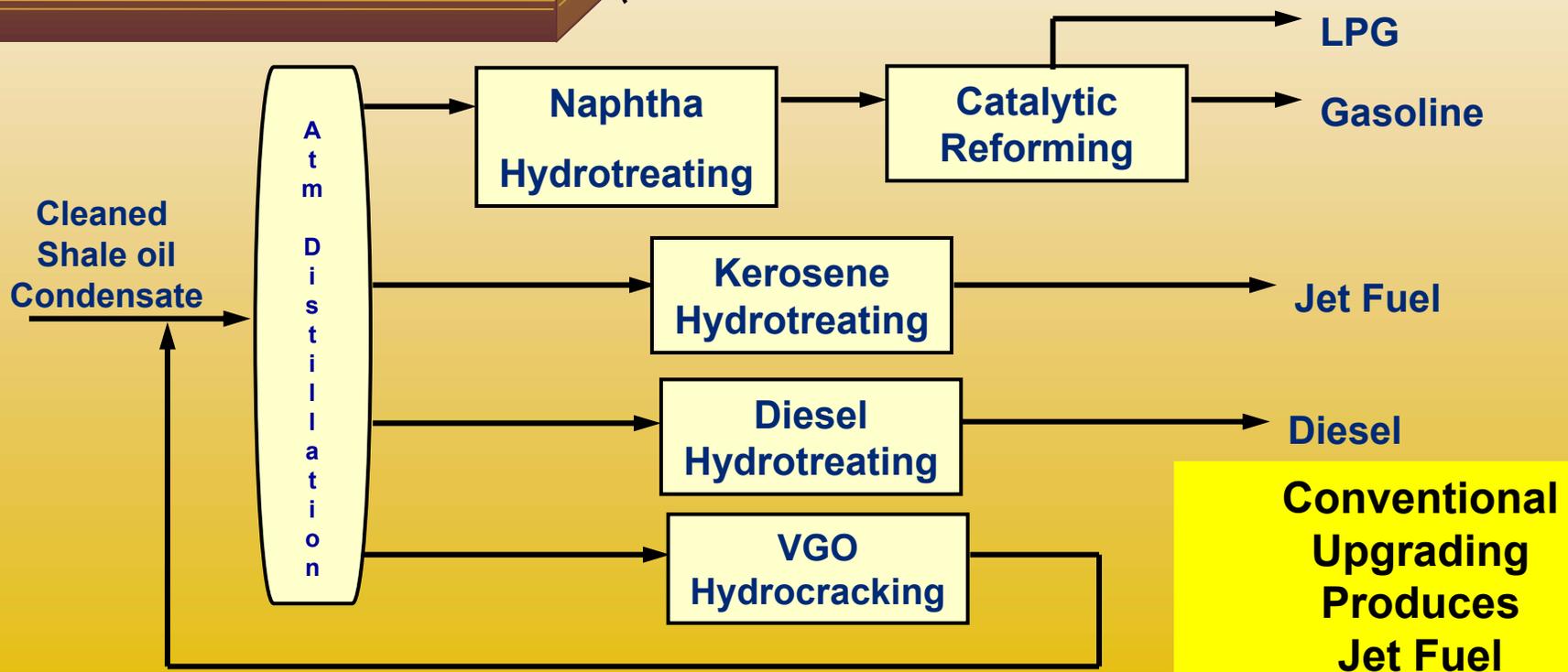
EASTMAN

National Security, Power Security, Food Security

Shell's In Situ Shale Oil Conversion Process



- Kerogen (shale oil) produced by *slow* heating with subsurface electric heaters
- Heat converts kerogen into oil (30+ API) and gas via a combination of thermal cracking and in-situ hydrogenation
- Products are brought to surface via traditional methods



Plant Financing Hazards Will They Get Built?

- Are alternative fuel plants viable at affordable fuel prices?
- Technology maturity – Operating reliability
- High capital cost of new systems (\$2 billion early FT plants – shale?)
- Site selection – Permitting – Environmental suits
- Land access issues
- Design and construction delays and cost over-runs
- Commissioning push-backs/cancellations (Shoreham)
- Fuel Price Volatility – Gas-powered plant experience
- Market acceptance of fuel - Off-take agreements
- Backer strength/experience – New business models
- Regulated vs. unregulated power segment

Plant Financing Hazards Risk Remediation

Federal Initiatives

Fuel Contracts - Price Floors
Impediments and Incentives
Energy Policy - Enabling Legislation
Harmonized Environmental Regulations
Credit – Loans – Tax Incentives
Research and Development

Financial Community

Understanding Federal/State Initiatives
Technology Maturity Education
Value Chain - Modeling - Simulation
Standardized, Simplified Fed Filings
Secondary Market Liquidity
Due Diligence - Credit Agency Assistance

State Governments

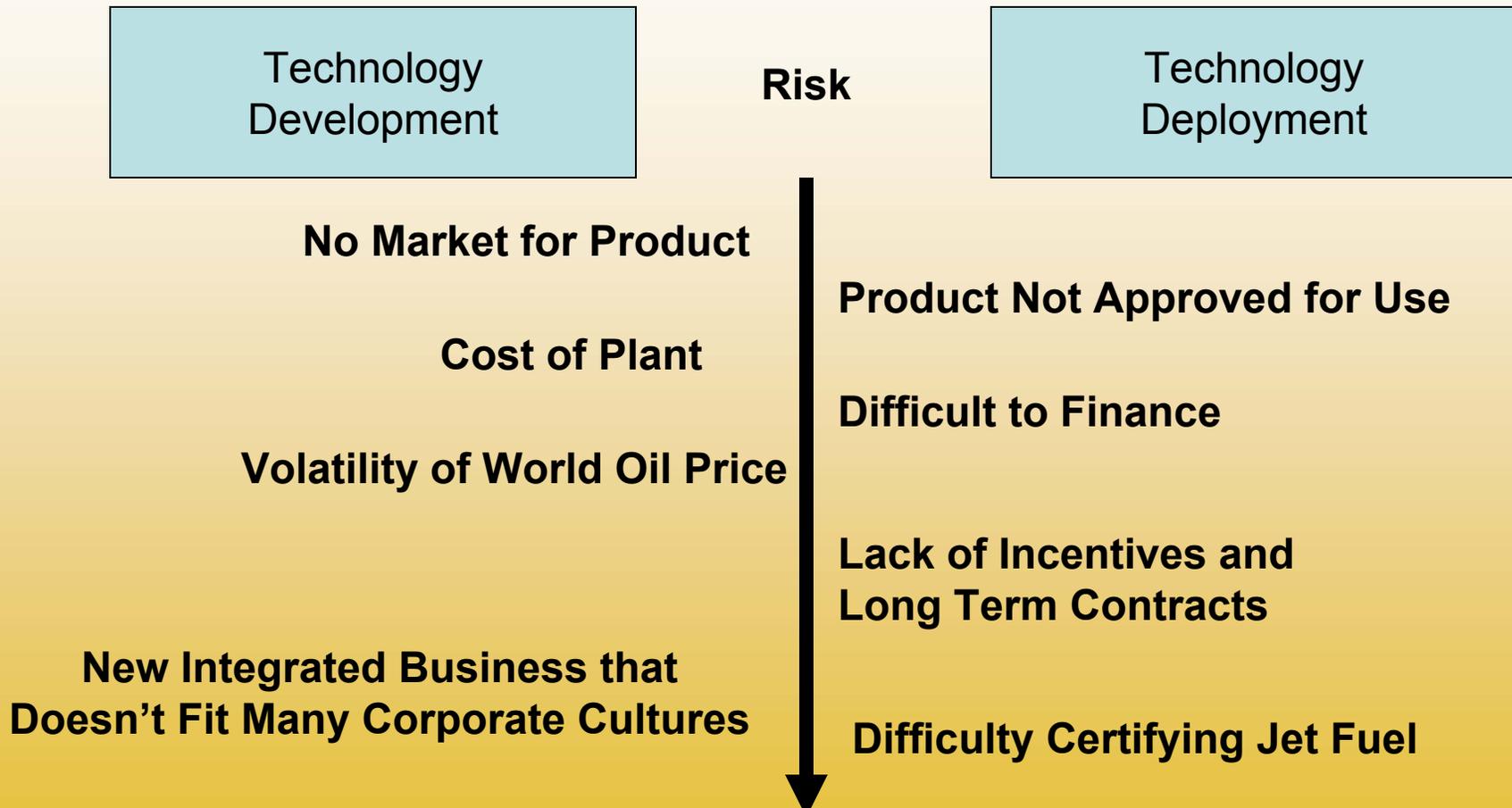
Grants – Loans – Tax Incentives
Expedited Sites and Permitting
Multi-state Collaboration
Harmonized Environmental Regs
State First Provider Fuel Purchases
Fertilizer Subsidies

Project Backers

Industry/Fed R&D – Fuel Specs
Early Fed Fuel Contract Signing
Wheeled Power to Oil Shale Projects
CO2 Sequestration – Oil Recovery
Technology Sharing - Standardization
IGCC Jet Fuel “Plug-in” Module

OSD/AT&L Clean Fuel Initiative

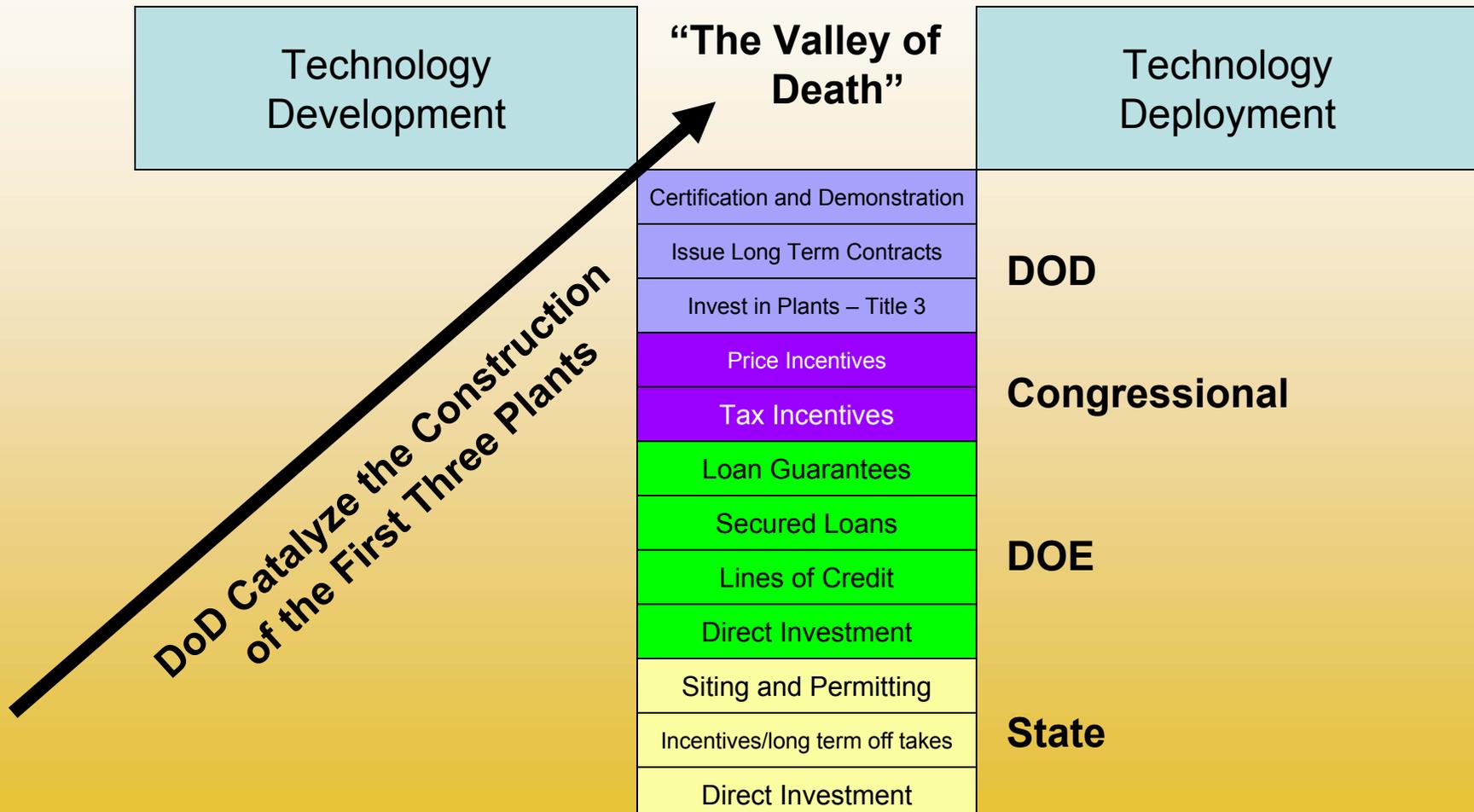
Hurdles and Impediments



"The Valley of Death"

DoD leadership key to bridging the "Valley of Death" to obtain secure, domestic sources of fuel

Industry Needs DoD Leadership

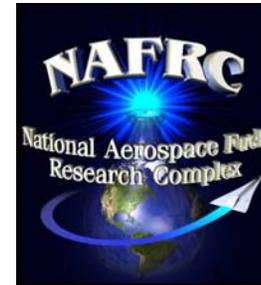


Clean Fuels Initiative Two Pronged Approach

- **Total Energy Development Program (TED)**
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- ➔ **Joint Battlefield Use Future Fuel of the Future (JBUFF) Program**
 - **Evaluate, demonstrate, certify turbine fuels from alternative energy resources for use in tactical vehicles, aircraft and ships**

Research Participants

- Air Force
 - Air Force Fuels Research Laboratory/NAFRC
 - University of Dayton Research Institute
- Army
 - TARDEC Fuels & Lubricants Laboratory
 - Southwest Research Institute
- Navy
 - NAVAIR Fuels and Lubricants Laboratory
 - Naval Fuels and Lubricants Integrated Product Team
- DoE
 - National Energy Technology Laboratory
- Syntroleum Corp.



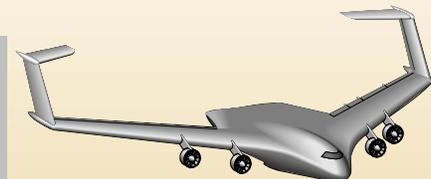
FT Fuels Improve Aerospace Propulsion and Power Systems

FT iso-paraffinic kerosene (100%)

low emissions, high stability

2.2X – 9X increase in cooling

Current and advanced gas turbine aircraft
(Jet A/JP-8 replacement)



High thermal stability, high H/C

No sulfur, no aromatics
No poisoning, less coking of reformer catalyst
high stability, endotherm
1200 Btu/lb cooling

Hypersonic Vehicles
(JP-7 replacement)



ISP=362.5



Hydrocarbon Rockets
(RP-1 replacement)

Hydrocarbon reformers
(fuel cell power generation)



FT Fuels Benefit Air/Ground/Marine Propulsion and Power Systems

FT Fuels **clean alternative to petroleum fuel (MADE IN USA)** **Alternative Fuel Vehicles (AFVs)**
 (non-tactical fleets; Post, Camp & Station)
 E.O. 13149, EPA Act



reduced exhaust pollutants
 lower CO, PM, NOx

easier starts, all climates
 high cetane, >74

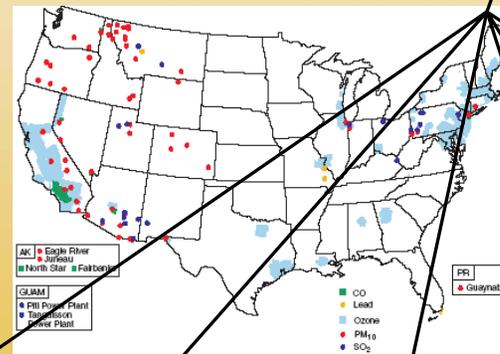
source of hydrogen

easily reformed

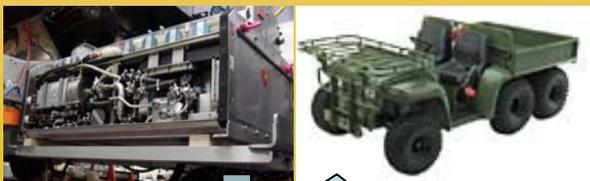
Diesel engine fleets



Fleets operating in non-attainment areas



Fuel Cell Applications (APUs in Vehicles)

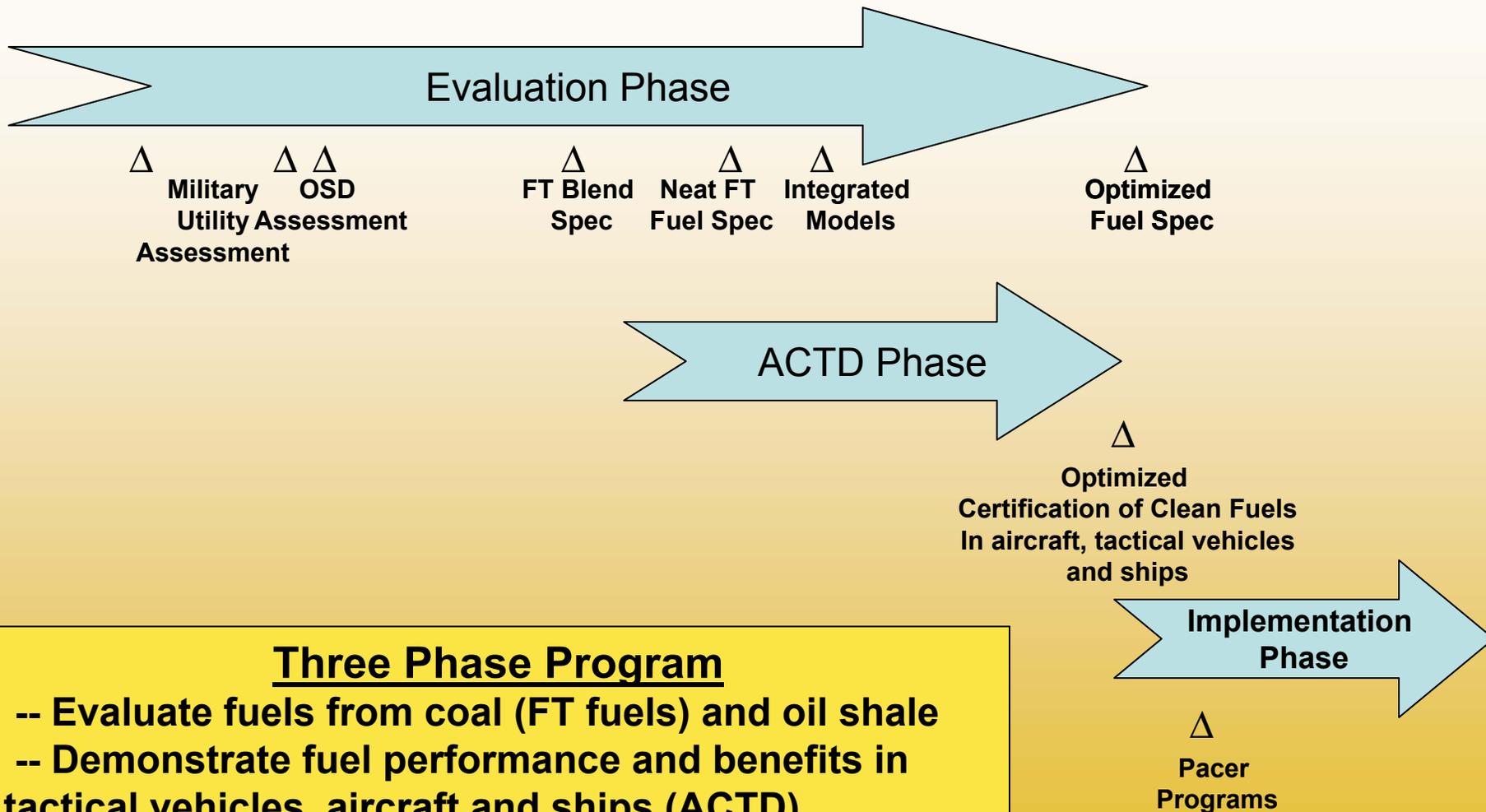


Battlefield Use Fuel of the Future (BUFF) **Program**

- **Evaluation Phase (2003 – 2009):**
 - Determine the characteristics of clean fuels
 - Develop specifications (FT Blends, FT and Shale Fuels)
 - Develop modeling and simulations tools
 - Qualify fuel at subcomponent level
 - Determine key logistic parameters
 - Determine health and safety benefits
- **ACTD Phase (2007 – 2009):**
 - Demonstrate, validate and certify clean fuels in tactical Vehicles, aircraft, ships and advanced technologies such as fuel cells, hybrid tactical vehicles, scramjets, rockets and advanced turbine engines
- **Implementation Phase (2010 – 201X):**
 - Implement lead the fleet Pacer programs in tactical vehicles, aircraft and ships
 - Develop full implementation plan based on commercial availability of clean fuels

Battlefield Use Fuel of the Future (BUFF) Program

2003	2004	2005	2006	2007	2008	2009	2010	2011
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Three Phase Program

- Evaluate fuels from coal (FT fuels) and oil shale
- Demonstrate fuel performance and benefits in tactical vehicles, aircraft and ships (ACTD)
- Deploy the fuel into the field

BUFF Program Phases

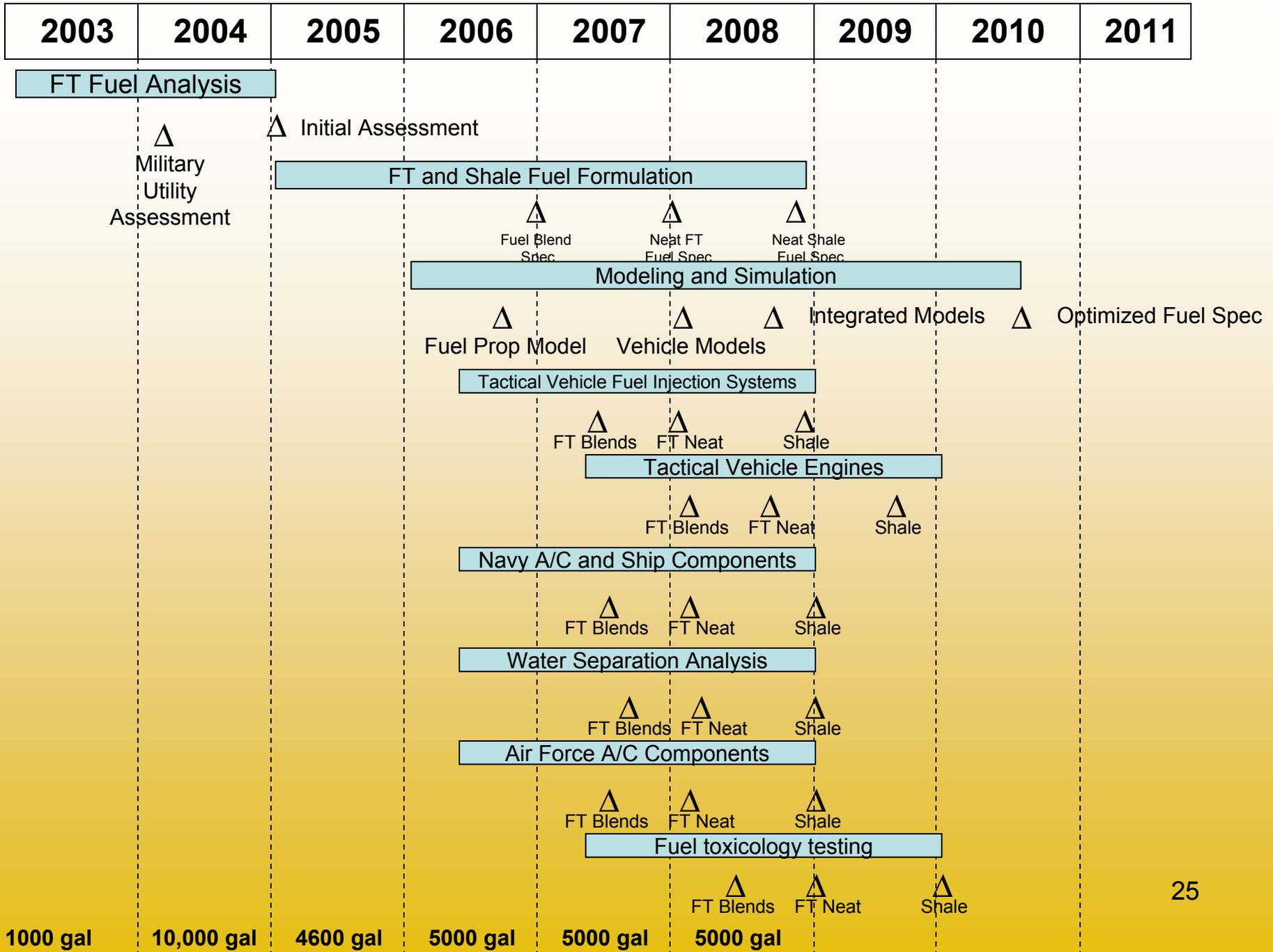


Evaluation Phase

ACTD Phase

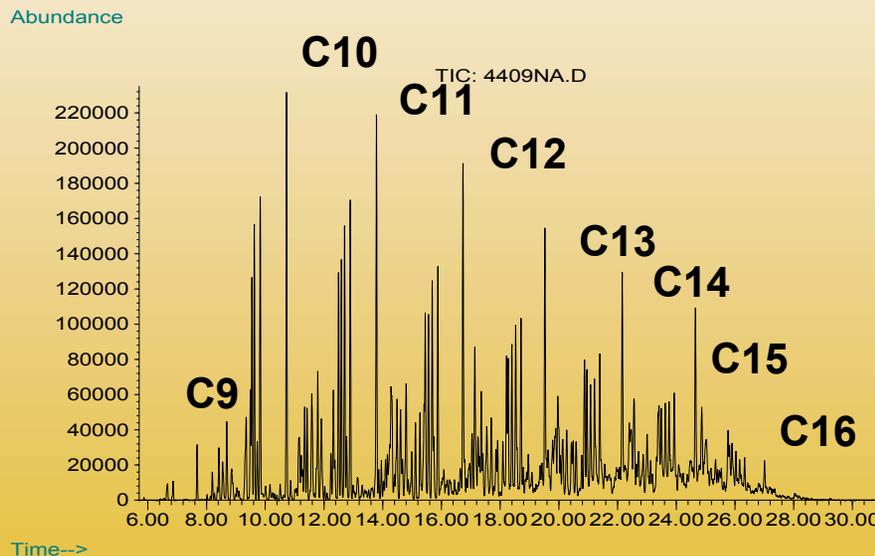
Implementation Phase

BUFF Evaluation Phase

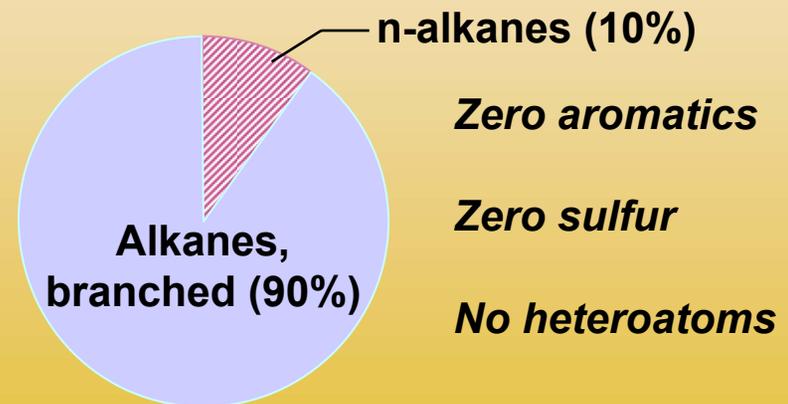


FT Fuels Reduce Emissions

- Less Pollutant Emissions
 - 2.4% less CO₂
 - 50% to 90% less particulate matter (PM)
 - 100% reduction in SO_x
 - ~1% less fuel burn (increased gravimetric energy density)



Hydrocarbon types in Syntroleum S-5



Zero aromatics

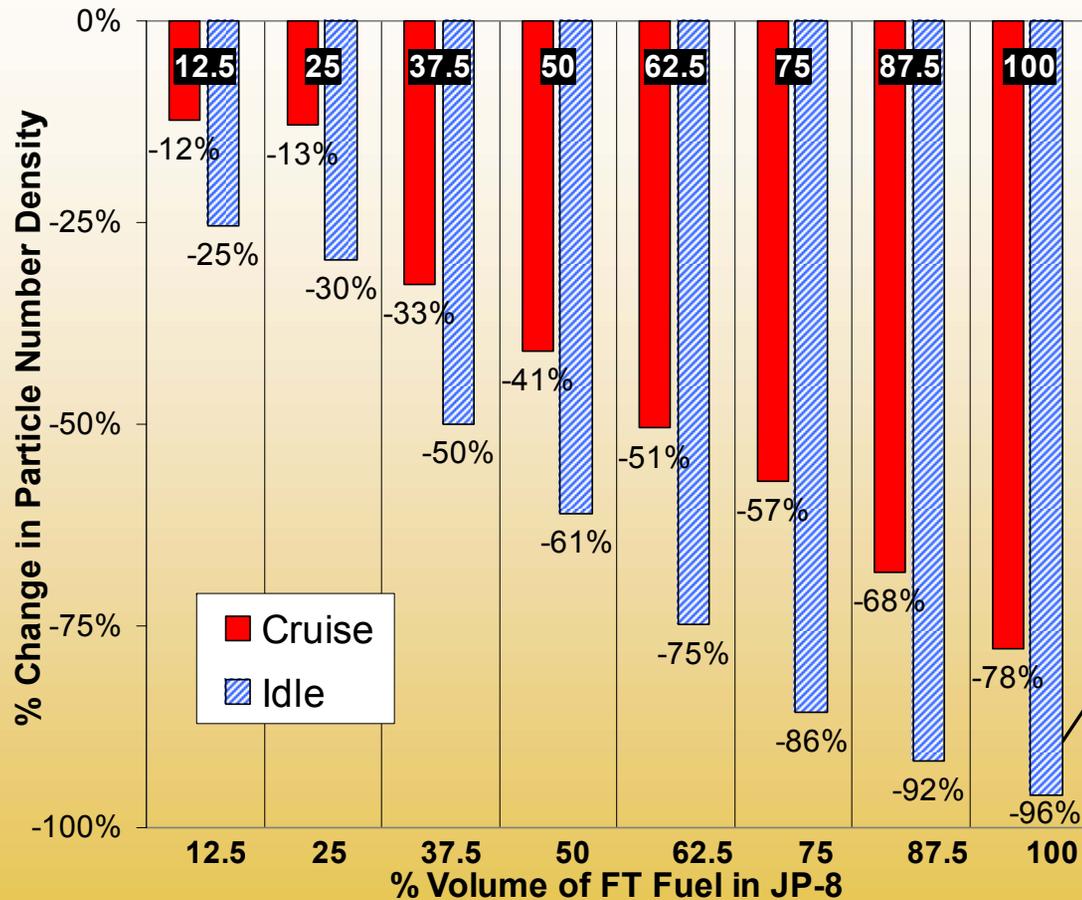
Zero sulfur

No heteroatoms

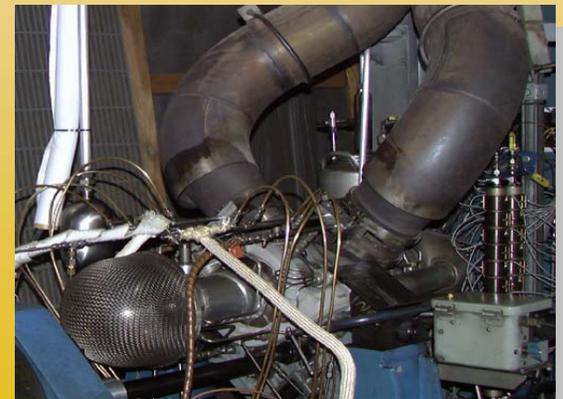
Highly Paraffinic Fuel – normal and isoparaffins

Petroleum derived fuels are rich in aromatics, cycloparaffins, and heteroatoms

Reduced Particulate Emissions with Fischer Tropsch Clean Fuel Relative to JP-8



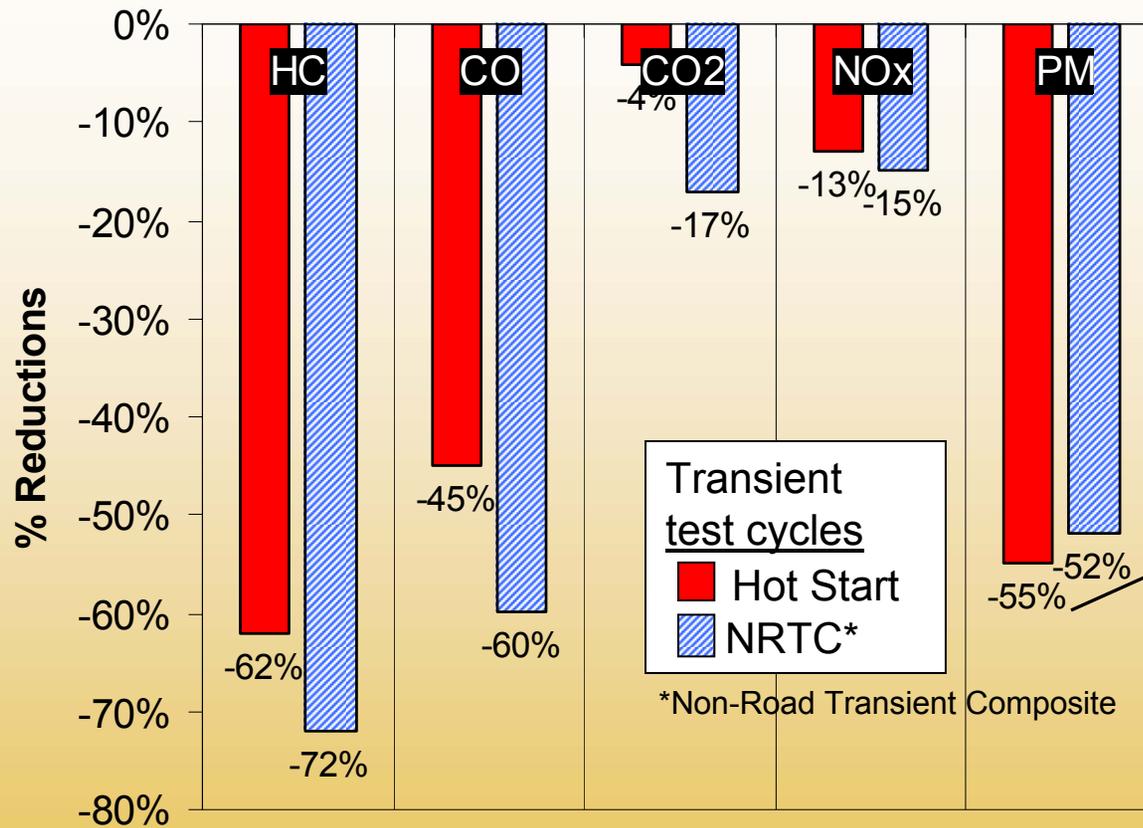
96% reduction* in particulate emissions at idle conditions.



Even moderate fractions of FT fuel blended in JP-8 significantly reduce exhaust emission particulates in T63 turbine engine testing.

* Note: Results are highly dependent on engine model/year and composition of baseline fuel.

Reduced Exhaust Emissions with Fischer Tropsch Clean Fuel Relative to Low-Sulfur Diesel Fuel

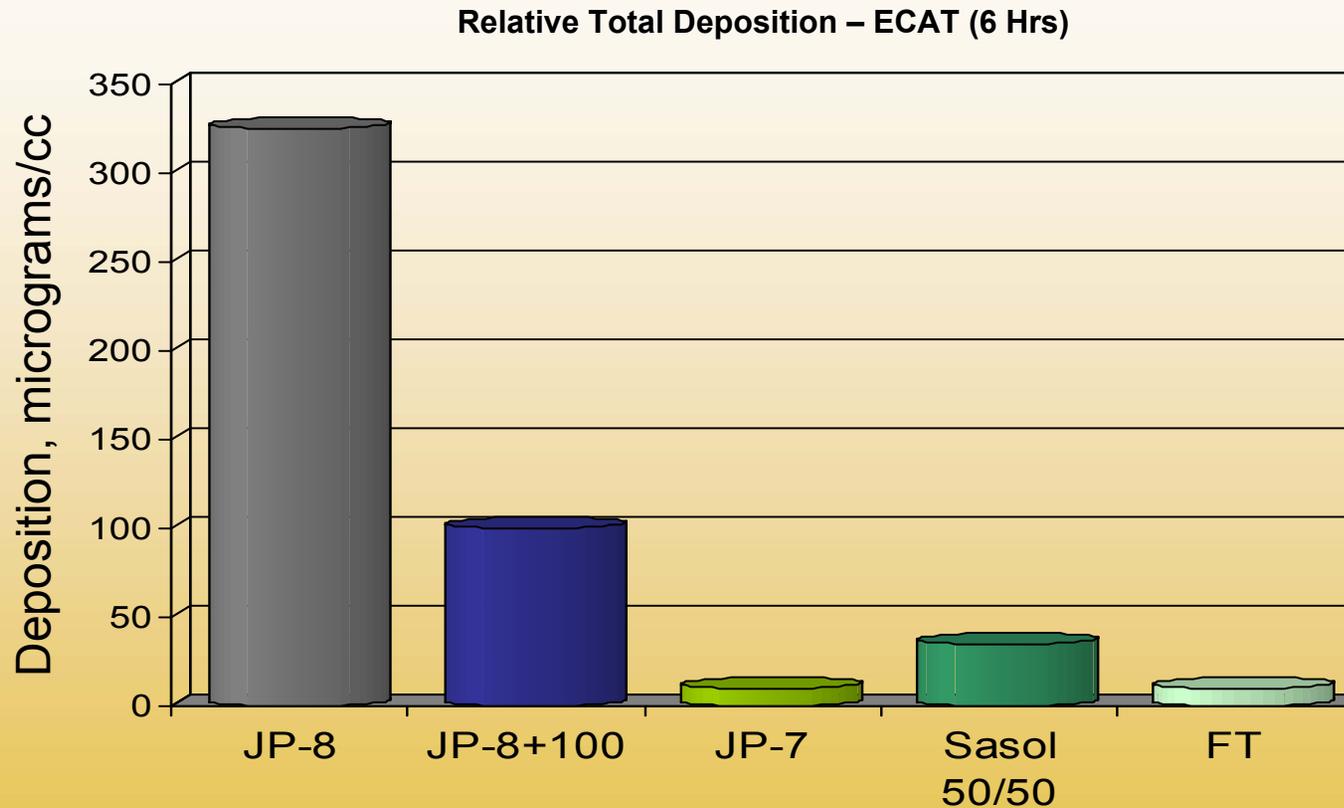


Over 50% reduction in particulate emissions in transient mode.



FT fuel burns more completely and emissions are significantly cleaner than EPA certified low-sulfur diesel fuel tested in 6.5L diesel engine.

FT Fuels Have Superior Thermal Stability



Increased fuel thermal stability enables development of very fuel efficient propulsion systems

JBUFF Program Phases

Evaluation Phase

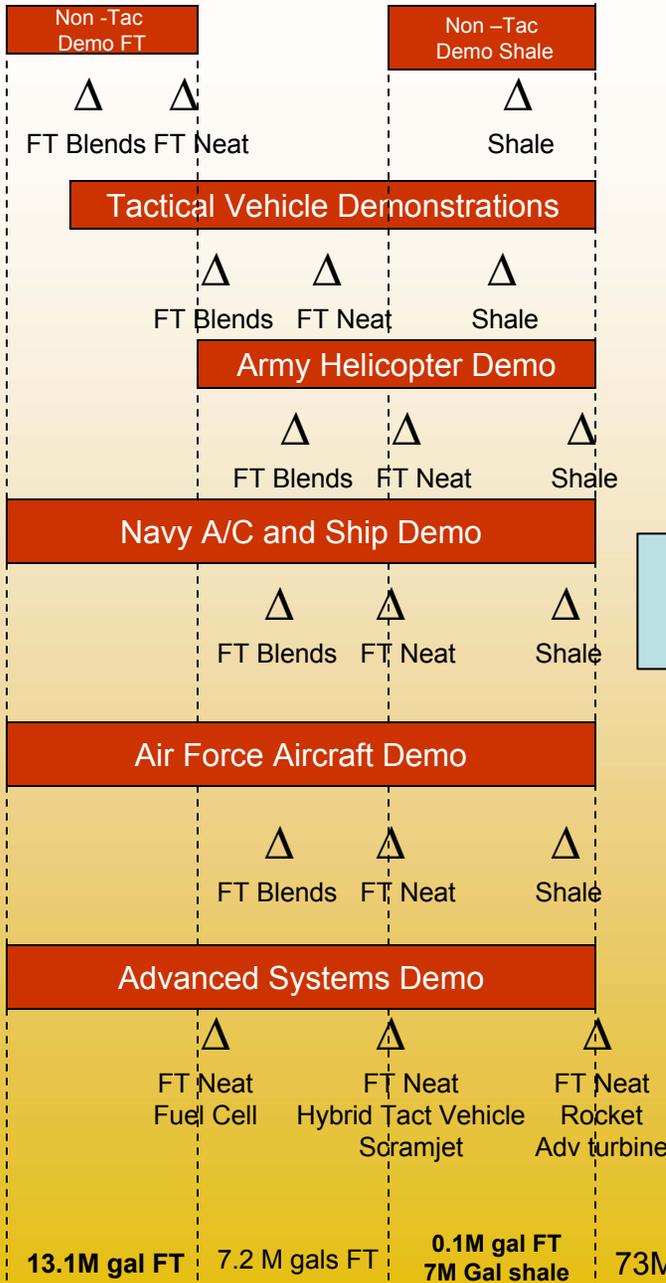


ACTD Phase

Implementation Phase

ACTD/Implementation Plan

2004	2005	2006	2007	2008	2009	2010	2011	2012
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Pre- ACTD Activities Continue

Implementation Phase

Program Elements
 Pre-ACTD BUFF
 BUFF ACTD
 Initial Implementation

JBUFF Program Phases

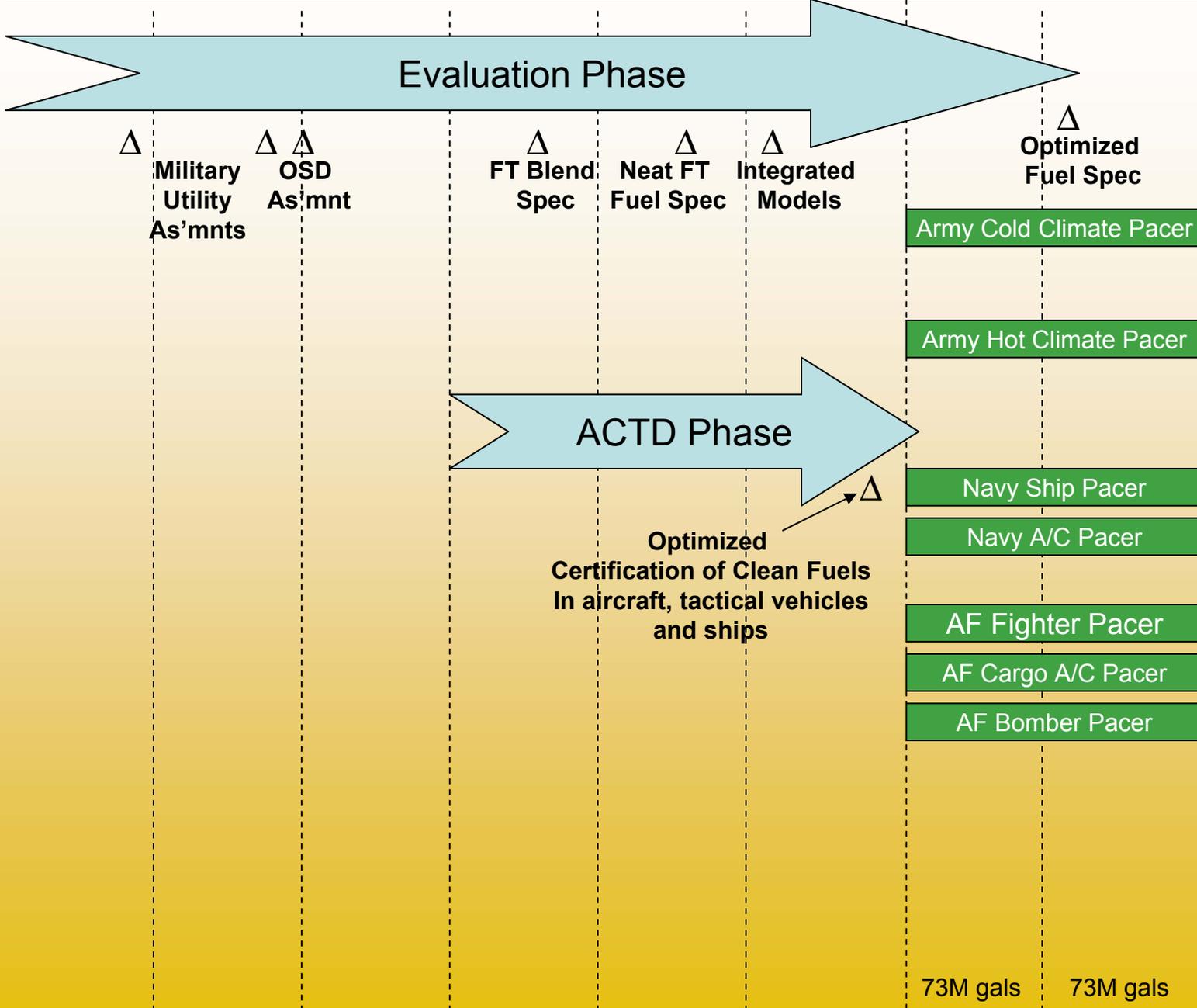
Evaluation Phase

ACTD Phase

→ Implementation Phase

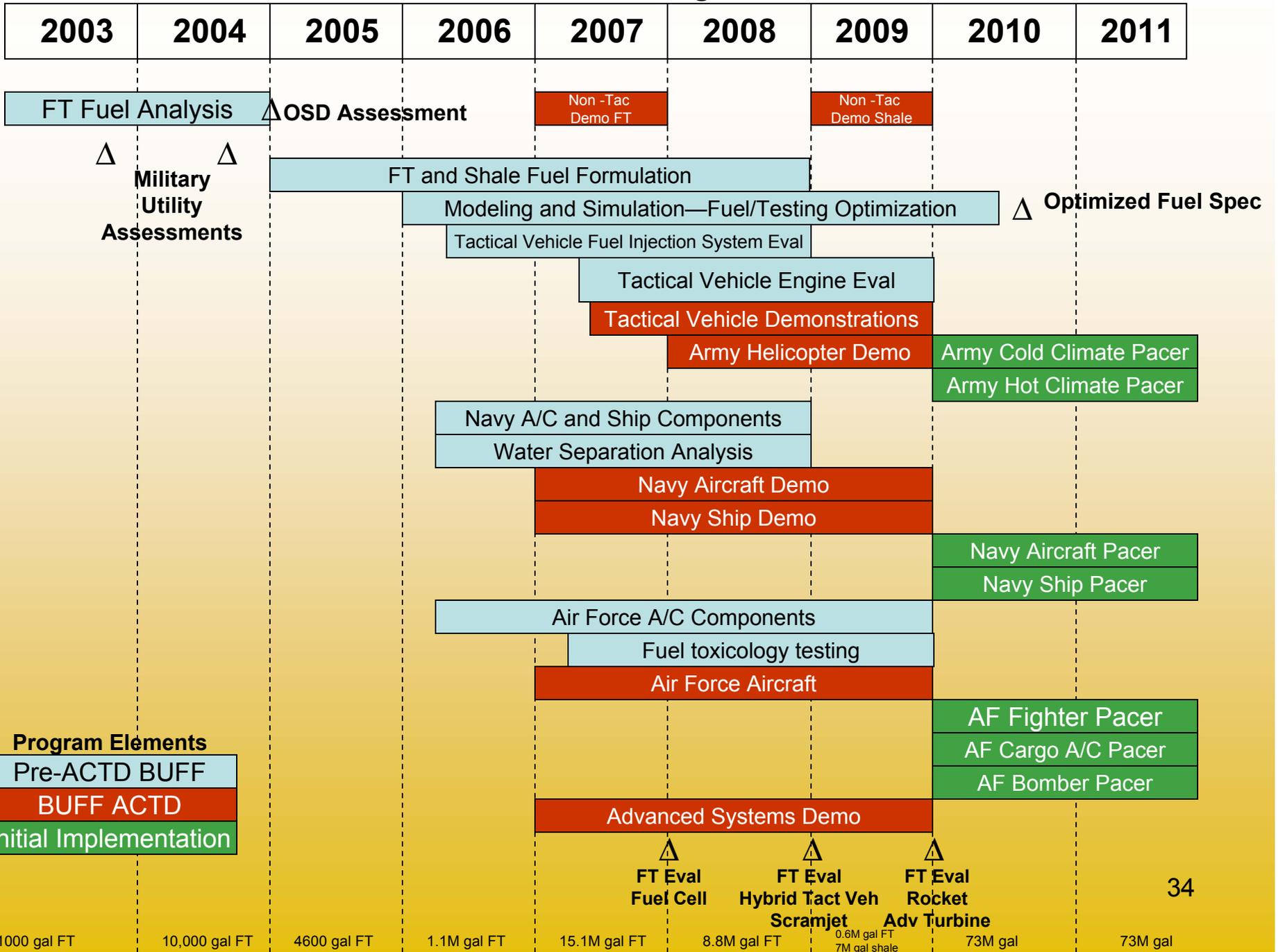
ACTD/Implementation Plan

2004	2005	2006	2007	2008	2009	2010	2011	2012
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FULL IMPLEMENTATION

Overall BUFF Program



Time for Action is Now!

- **US need for secure clean energy is real and growing**
- **DoD has a vested interest in catalyzing the development of energy resources to reduce dependence on foreign oil**
- **DoD would like to see all energy resources developed in an integrated fashion**
- **State Governors can be our bridge between the government and private industry to develop the vast energy resources in the US**
- **Coal, Oil Shale and Petroleum Coke are the near term source of Clean Fuels (New Middle East)**
- **Joint participations by other government agencies (EPA, DOT, FAA, HSA, Commerce, Interior) strengthens the program**
- **Open invitation to all industrial, government (state and federal), and academic partners to participate in our Initiative**

Questions?